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The fatty acid profiles of meat from calves fed linseed of oily cultivars

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Summary

The effects of supplementing full fat linseeds (*Linum usitatissimum* L. *convar. mediterraneum*) cultivar Opal and ecotype Linola on the fatty acids composition of muscle were investigated with 18 bull calves divided into 3 groups (n=6). Animals of the control group (C) were given a basal concentrate mixture additionally to a whole milk, and animals of the experimental groups were offered the same diet of which the concentrate was supplemented with linseeds from cultivar Opal (LO) rich in C18:3 n-3 (47,4%) of total FA) or Linola (LL) rich in C18:2 n-6 (65.6%). Groups were divided into 2 sub-groups differing by the slaughtering age of calves: 42 or 90 days. Samples of *Musculus thoracis (MT))* were taken for fatty acid analysis. In MT muscle, fatty acids from total lipids did not differ between diets except for C18:3 n-3, CLA and C22:6 n-3 which tended to be higher in LL and LO than in group C and for C20:4 n-6 which tended to be higher in the LL group than in C and LO group, but differences were not significant. Fat of meat of calves slaughtered at 42 days of age was characterized by lower UFA/SFA ratio than fat of meat of calves at 90 days of age.

Keywords: calf, linseed, meat, fatty acids profiles

Introduction

The experimental results showed that composition of fat of young ruminants could be modified by the diets (Jenkins and Kramer 1990; Wachira et al., 2002). A significant increase in the essential unsaturated fatty acids, especially C18:3 n-3 and conjugated fatty acids in deposited meat tissue fat was found in fattening bulls receiving concentrate mixture containing 19% ground linseed (Strzetelski et al., 2001). Linseeds of oily cultivars are different in chemical composition and fatty acid profiles (Borowiec et al., 2001). As the calves grow intake of solid feed increase and it may much more affect on fatty acids profile of muscle tissue than ingestion of liquid feed. The effects of milk and seeds from traditional and new "high linolenic" or "high linoleic" oily cultivars in calf diets on fatty acid profiles of meat are not fully examined.

The aim of the experiment was to study the effects of dietary supplementation with linseed from oily cultivars Opal and Linola on the fatty acid composition of veal meat.

Material and methods

The experiment was carried out on 18 Black-and-White Lowland bull calves (67.5% HF) randomly assigned at 7 days of age to 3 experimental groups of 6 animals each. Full fat dark-seeded linseed (*Linum usitatissimum* L. *convar. mediterraneum*) cultivar Opal and yellow-seeded ecotype Linola were used as the main source of fat in experimental diets. In the control group C calves were offered the basal concentrate diet without linseed, in group LO they received 11% seeds of cv. Opal and in group LL 10.5% seeds of ecotype Linola. Concentrate diet consisted on a percentage basis of: ground barley (44-50), ground wheat (23-37), soybean meal (12-15) and minerals (4). Groups were divided into 2 sub-groups: slaughtered at 42 and 90 day of age. The samples of *Musculus thoracis* (MT) were taken for analysis.The requirements of calves, whole milk feeding schedule (from 7 to 56 days of age) and the composition of the concentrate diets were based on feeding standards (IZ-INRA, 2001). The chemical composition of the concentrate diets was determined according to AOAC (1990). The fatty acids (FA) composition of the concentrate diets and MT were determined by gas chromatography (Pye Unicam Sc 104, 30 m column Supelcowax).

The results were statistically analysed using a two-way analysis of variance SAS (1989), taking into account the type of diets and the slaughter age. Differences were declared significant at $P<0.05$.

Results

The chemical composition and nutritive values are given in Table 1. The crude protein (CP) and energy content in all concentrates were similar, but the highest content of PDI and lowest of ether extract (EE) was found in concentrate mixture C.

Table 1. Chemical composition and nutritive value of feeds

Feed	Dry matter %	Content (kg^{-1} dry matter)							
		Crude protein g	Ether extract g	Crude fibre g	Ash g	UFL(1)	PDIN(1) g	PDIE(1) g	% of linseed EE in total EE
Linseed var.									
Opal	90.87	285.5	377.2	163.2	39.2	1.47	149	44	
Linola	92.49	216.4	416.9	210.8	42.4	1.48	125	36	
Whole milk	12.56	264.2	318.2	-	63.6	0.24	250.9(2)		
Diets									
C	87.6	178.0	23.88	41.97	28.2	1.14	123	127	
LO	88.2	182.1	55.74	39.12	14.1	1.15	118	113	76,6
LL	87.9	174.8	59.19	44.50	16.1	1.15	115	112	77,5

(1) IZ-INRA (2001): UFL- unit of energy for milk production; PDIN- protein digested in the small intestine dependent on rumen degraded protein; PDIE - protein digested in the small intestine dependent on rumen-fermented organic matter

(2) digestible crude protein of milk for preruminant calves

The average intake of concentrate diets by the one calf to 42 days of age was 5.20±1.1 kg and to 90 days of age was 83.1±5.2 kg. The mean daily intake of nutrients by calf for all period of experiment were: 1.36±0.05 kg dry matter, 280±9.5 g crude protein, 225±6.5 g PDI and 1.91±0.06 UFL.

Seeds ecotype Linola were characterized by the higher Cn-6/Cn-3 ratio, higher C16:0, C18:2 n-6 and lower content of C18:3 n3 in fat compared with fat from cv. Opal (Table 2). Concentrate diets LO and LL were characterized by a higher UFA/SFA ratio (1.6 and 1.8 times) compared with concentrate C. The higher content of C18:2 n-6 in FA of LL concentrate diet (62.5%) and of C18:3 n-3 in FA of LO concentrate (38.0%) in comparison with C concentrate (53.2% and 5.5%, respectively) were found. The content of C18:3 n-3 in FA of LL concentrate diet was lower (3.4%) in comparison with LO concentrate.

Table** 2. Fatty acid composition of linseed **and diets

Item	Seeds of linseed var:		Diets:		
	Opal	Linola	C	LO	LL
SFA					
14:0	0.231	0.139	0.308	0.256	0.187
16:0	4.624	7.587	17.981	7.830	10.228
18:0	4.644	4.033	2.127	4.069	3.578
22:0	0.085	0.336	0.205	0.107	0.300
24:0	0.105	0.196	0.190	0.119	0.190
Total SFA	10.544	12.732	21.388	13.176	14.958
UFA					
16:1	0.225	0.163	0.323	0.237	0.190
18:1	21.337	17.933	16.144	20.074	17.423
18:2 n-6	18.806	65.612	53.237	26.346	62.518
18:3 n-3	47.444	2.644	5.525	38.048	3.360
20:1	0.312	0.289	0.660	0.400	0.386
24:1	0.000	0.230	0.120	0.028	0.205
Total UFA	88,333	86.940	76.242	85.350	84.193
UFA/SFA	8,38	6.83	3.56	6.48	5.63
n6/n3	0.40	24.82	9.64	0.69	18.61

Meat samples of all groups were characterized by an average of 24.7±2% dry matter and a protein to fat ratio was: 8.12 (C), 10.86 (LO) and 11.37 (LL). In MT fat of LO and LL groups there were tendencies for higher level of C18:3 n-3, EPA, DHA and CLA and lower value of n-6/n-3 ratio as compared with group C (Table 3). The lowest content of C16:0 ($P<0.05$) and the highest of C18:0 ($P<0.05$) were found in the LL group as compared with others. The intramuscularly fat of calves slaughtered at 42 days of age was characterized by lower UFA/SFA ratio than that from calves at 90 days of age.

Discussion

Despite the lack of differences in UFA/SFA ratio in FA profile of *Musculus **thoracis*** fat, the concentrates with linseed could have increased the supply of some UFA to the small intestine. As the rumen developed, part of UFA could have become biohydrogenated. However, due to a higher fat proportion in the concentrate diets with linseeds, the biohydrogenation process could have been restricted and some UFA supply to the duodenum may have been relatively high Wu et al. (1991) stated that supplementary fat in the diet linearly increases fatty acids passage into the duodenum, creating the conditions for absorption from the small intestine. The somewhat greater deposition of C18:3 n-3 and C18:2 n-6 in MT of calves in groups LO and LL than in C groups was probably due to the high fat content of linseeds and its level in the concentrates and to FA proportions because feed intake being similar in all groups.

The differences in SFA and UFA in the meat fat of calves before and after weaning indicate that the proportions of UFA and particularly PUFA were mainly influenced by concentrate diets. For the first stage of growth, characterized by low solid feed intake, the meat fat contained more SFA than UFA, which was mainly due to the FA composition of milk fat and suggests that they could be absorbed similarly as in monogastric animals

(Hocquette and Bauhart, 1999). The somewhat higher concentration of linolenic acid in the veal meat of calves receiving linseed cultivar Opal, compared with LL group, could be explained by the higher intake of this acid. The increased proportions of CLA in MT of calves in these groups could result from changes of C18:2 n-6 or C18:3 n-3 (Stasiniewicz et al., 2000). Possibly, this had a beneficial effect on limiting fat synthesis, as evidenced by a greater protein to fat ratio in LO and LL than in control group (Steinhart et al. 1998).

Conclusion

Feeding calves with concentrate diets with 10% of linseed Opal or Linola makes it possible to increase the PUFA content of veal meat of calves slaughtered at 90 days of age. Fat of meat obtained from calves at 42 days of age during the milk-feeding period was characterized by lower UFA/SFA ratio than fat of meat obtained from calves at 90 days of age.

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Table 3. Effect of diet and age of calves on the MT fatty acid composition

Item	Main effects of: Diets: C[(1)]	LO[(1)]	LL[(1)]	LS =[(2)]	Age of calves (days) 42	90	LS	Means:	SE	Interaction
SFA										
C 12:0	0.43	0.42	0.28	0.21	0.41	0.35	0.51	0.38	0.19	NS
C 14:0	2.85	2.54	2.41	0.19	2.87	2.35	0.06	2.59	0.62	*
C 16:0	22.54[a]	22.63[a]	20.41[b]	0.04	23.62	19.97	0.01	21.80	2.81	**
C 18:0	13.90[b]	14.26[ab]	15.64[a]	0.04	14.22	14.98	0.21	14.60	1.45	NS
C 20:0	0.033	0.040	0.025	0.32	0.031	0.034	0.78	0.03	0.02	NS
C 22:0	0.12	0.003	0.013	0.29	0.010	0.009	0.81	0.009	0.01	NS
Total SFA	39.76	39.89	38.59	0.31	41.16	37.66	0.01	39.42	2.98	*
UFA										
C 16:1	3.14[ab]	3.41[a]	2.49[b]	0.02	3.07	2.96	0.69	3.016	0.64	*
C 18:1	31.79	30.31	29.71	0.21	30.54	30.67	0.70	30.61	2.56	NS
C 18:2 n-6	12.05	12.18	12.94	0.79	11.79	12.32	0.52	12.05	1.69	NS
C 18:3 n-6	0.09	0.11	0.13	0.17	0.9	0.12	0.12	0.11	0.06	NS
C 18:3 n-3	0.66	1.06	0.94	0.20	0.56	1.21	0.02	0.89	0.60	NS
CLA	0.41	0.51	0.47	0.30	0.49	0.41	0.29	0.45	0.16	NS
C 20:4 n-6	1.95	1.93	2.90	0.08	1.93	2.59	0.10	2.26	0.94	*
C 20:5 n-3 EPA	0.32	0.25	0.45	0.07	0.28	0.40	0.96	0.34	0.18	NS
C 22:6 n-3 DHA	0.39	0.50	0.49	0.08	0.47	0.45	0.71	0.46	0.92	NS
Total UFA	50.81	50.27	50.48	0.51	49.21	51.17	0.22	50.19	3.05	NS
UFA/SFA	1.29	1.27	1.31	0.83	1.2	1.37	0.04	1.28	0.16	NS
n-6/n-3	9.26	7.88	7.19	0.11	9.50	6.71	0.02	8.11	2.55	*

[(1)] C – control diet, LO- with linseed Opal, LL- with Linola,

[(2)] *LS – level of significance; a,b and * -P< 0.05; lack letters or NS-no statistically significant*